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ABSTRACT

This guide is designed to accompany ESPN's SportsFigures video segments which were created to enhance the interest and learning progress of high school students in mathematics, physics, and physical science. Using actual, re-enacted, or staged events, the problems presented in each of the 16 Sports Figures segments illustrate the relationship between a sports situation and the related mathematical or physics principle. Lesson plans include descriptive sections on academic topics, academic courses, athletic activity, problem background, methodology, lesson extensions, and worksheets. The lessons are related to topics on basic statistics, percent, averages, rates, gravitational potential energy, force, velocity, acceleration, torque, Newton's laws, center of gravity, energy, standing waves, pressure, density, aerodynamics, molecules, and basic geometry. Contains an answer key. (DDR)

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ESPN SPORTS FIGURES

makes math and physics a ball!

1996-97 educator's curriculum

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About SportsFigures

Imagine understanding math and physics by learning the dynamics of white water kayaking. Or geometry by the trajectory of a ninth inning grand slam home run. That's what ESPN2's SportsFigures is all about.

SportsFigures uses sports—the athletes, the playing field/the competitive spirit and the quest for excellence, plus the medium of television—to teach core mathematics and physics concepts to high school students.

About This Guide

This guide is designed to accompany ESPN2's SportsFigures video segments. If desired, these lessons are appropriate for use independent of the videos. Consistent with the national focus on raising standards and improving student achievement, the SportsFigures curriculum guide was created to enhance both the interest and the learning progress of mathematics, physics and physical science to high school students.

Classes will benefit most from ESPN2's SportsFigures if video segments are viewed in conjunction with related lessons. Using actual, re-enacted or staged events, the problems presented in each of the 16 SportsFigures segments illustrate the relationship between a sports situation and the related mathematical or physics principle.

The instructor will be able to make appropriate selections by referring to the table of contents, and to the materials which were designed to accompany each video segment. The lesson plans are categorized into the following descriptive sections:

Specific Skills: Specific skills and/or topics covered in the lesson.

Academic Courses: Courses which contain the related academic topics in the curriculum.

Athletic Activity: The sports situation displayed in relation to the academic topic.

Problem Background: Description of the sports situation with explanations and definitions of related facts and/or terms.

Methodology: The approach and the solution to the problem presented on the video and in the lesson.

Extension Ideas: Suggested options for instructors to expand upon and/or enrich the topics.

Activity Sheet: Adjacent to each lesson plan is a reproducible worksheet for students which includes follow-up questions and practice exercises for classwork or homework.

With SportsFigures, ESPN continues its commitment to providing teachers with more meaningful and innovative educational programs.

For more information about ESPN's Cable in the Classroom programs, you can write to us at: ESPN, ESPN's Cable in the Classroom Dept., ESPN Plaza, Bristol, CT 06010. Call us at: (860) 585-2000. Or reach us on the internet; our address is: http://espnet.sportszone.com.

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Streaking Strategies

Lesson Plan

Academic Topics: Percent, basic statistics

Academic Courses: Basic math, pre-algebra or algebra

Athletic Activity: Basketball

Background: In basketball, players are called "streak shooters" if they appear to shoot better after a successful shot than after a missed shot. While many sports fans and players are strong believers in hot and cold streaks, some statisticians aren't convinced that such streaks exist. In this segment, we investigate the streak shooting issue by performing our own experiment.

Methodology: We begin with the basic description of streak shooting and then raise the question of how to determine whether streak shooting exists. First, we consider counting hits and misses after a shot is made. We use the table shown below. As the shooter is shooting, the students tally the data. After completing the experiment we must then decide how to interpret the data. We decide that counting the hits and misses after a hit is not a good indicator because there's no way to compare his success after hit shots to that after missed shots.

	After Hit	After Miss
Hit		
Miss		

What we need to compare is the *percentage* of shots made after a miss and a hit, respectively. If, following a hit, the player makes 15 and misses 30 shots, then his percentage after a hit is $15/(15+30)=33\frac{1}{3}\%$. We then compute his percentage following a miss in the same way. If the player makes a higher percentage of shots following a good shot than following a bad one, then the experiment supports streak shooting; otherwise, the experiment doesn't support it. We tabulate the data as shown below.

In the video segment experiment, the shooter made 80% of his shots after his hits and only 52% after his misses, so our experiment suggests the shooter is a streak shooter.

Extending the Lesson:

- *Does the experiment prove or disprove the concept of "streak shooting"?*

- *How can we improve the experiment? How may our experiment be biased?*

- *Have the students conduct their own experiment with players from the school's basketball team. Perhaps they could watch part of a practice in which players practice free-throws.*

- *Have students design a similar experiment in which they can record data and determine if there is a trend. One suggestion is to have the students make a list of 100 integers. Letting an even number represent a miss and an odd number a hit, repeat the experiment above with the integers as data. You could also use multiples of 3 as misses, as non-multiples, as hits, etc. (But don't tell the students what the numbers are for until after their lists are made!)*

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Streaking Strategies

Activity Sheet

1 *Do the data in the table shown below suggest that the shooter is a streak shooter or not?*

	After Hit	After Miss
Hit	11	23
Miss	22	43

2 *The table below shows the results from a streak shooting experiment, where* **w**, **x**, **y**, *and* **z** *are the numbers in the indicated squares. What are the possible values of* **x**-**y**? *(Try a few sample experiments by flipping a coin, letting heads represent a made shot and tails a miss.)*

	After Hit	After Miss
Hit	w	x
Miss	y	z

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Academic Topics: Averages, rates and distance

Academic Courses: Basic math, pre-algebra

Athletic Activity: Cycling

Background: In this segment we explore the effects of pacing yourself when cycling. Specifically, we compare the time it takes to go 2 miles at 15 miles per hour to the time it takes to go 1 mile at 10 mph, then another mile at 20 mph.

Methodology: First, we try comparing the two strategies by finding the arithmetic average of the rates of the two miles for each strategy. The first strategy has an average of $(15+15)/2 = 15$ mph, and the second an average of $(10+20)/2=15$ mph. The averages are the same, so the two strategies should be the same, right? Not so.

The average rate over the two miles is not the arithmetic average of the rates! We need to consider the time each strategy requires to cover the two miles. Using the familiar equation

$$rate \times time = distance,$$

we find that going 15 mph over 1 mile takes (1mile)/(15 mph) * 60 min/hr=4 minutes. Hence, going 15 mph over 2 miles requires 8 minutes; thus, the average rate is $2/8 = 1/4$ mile/min, or 15 mph. One mile at 10 mph takes 6 minutes and one mile at 20 mph takes 3 minutes for a total of 9 minutes. The latter strategy then covers 2 miles in 9 minutes — a rate of $2/9$ mile/min or $40/3$ mph. Thus, the latter strategy is clearly slower and our initial approach of arithmetically averaging the rates is proven incorrect.

Extending the Lesson:

- *Use the segment to initiate a discussion of arithmetic, geometric, and harmonic averages. Which of these is relevant to finding our average rate?*

- *Should your students be skeptical, find bikes outfitted with odometers and replicate the experiment.*

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featured athlete in the video:

CHIPPER JONES & JASON SCHMIDTS: Atlanta Braves Infielder, Chipper Jones graduated from Bolles High School in Jacksonville, Fl. Jones led Bolles to a state championship with a .448 batting average. Jason Schmidts is a graduate of Kates High School in Washington where he played football, baseball, and basketball. Schmidts was named Gatorade State Player of the Year and All- State.

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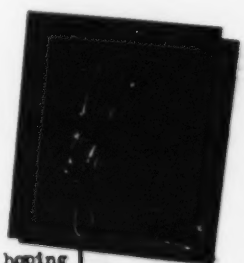
Not Your Average Average

1 *Given two numbers* **x** *and* **y**, *the arithmetic mean is* $(x+y)/2$, *the geometric mean is* $\sqrt{xy}$, *and the harmonic mean is* $2/(1/x + 1/y)$. *Which of these means is appropriate for determining the average rate a biker rides when she rides one mile at* **10 mph** *and another mile at* **20 mph**?

2 *Which of the three means above is appropriate for finding the average rate a biker rides when she rides one* **hour** *at* **10 mph** *and another hour at* **20 mph**?

3 *Find the average rate a biker rides when she rides one mile at* **10 mph**, *two more miles at* **20 mph**, *and one mile at* **30 mph**.



featured athlete in the video:

VERMONT WOMEN'S CYCLING TEAM: The Vermont Women's Cycling Team was founded in 1995 by women hoping to unite many of Vermont's talented road and off-road cyclists. The organization helps women riders get into racing, develop training schedules and assists in establishing sponsorships for them.

Energizer Bungy

Lesson Plan

Academic Topics: Gravitational potential energy, springs

Academic Courses: Physics

Athletic Activity: Bungy jumping

Background: How do bungy jumpers decide how long their cord should be? Obviously, if it's too short it's okay, but then they couldn't make those neat commercials where they barely dip in the water. And if it's too long...

Methodology: We solve this problem by using an energy balance. Specifically, we compare the gravitational potential energy of the jumper before the jump to the potential energy in the bungy cord when the cord is fully extended.

We use a platform of 160 feet and want our jumper to stop 8 feet short of the ground. Therefore, he has potential energy for falling 152 feet. Potential energy is given by mgh, where m is the mass of the jumper and g the acceleration due to gravity. Our jumper weighs 150 pounds and g is 32 ft/s^2, so the potential energy is 729,600 ft^2 lbs/s^2.

Now we need to compute the potential energy of the extended cord. Letting L be the unstretched length of the cord, the cord is stretched $152-L$ feet once the jumper has fallen 152 feet. The potential energy of an elastic object such as a spring or a bungy cord which has been stretched x feet beyond its natural state is $\frac{1}{2}kx^2$, where k is the spring constant. The spring constant represents how stretchy the cord is. We determine that our bungy cord has a k value of 112 lbs/s^2, so the potential energy of the extended cord is $56(152-L)^2$.

Due to the conservation of energy, our two energy figures must be equal. Solving the equation

$$56(152-L)^2 = 729{,}600$$

gives us $L = 37.85$ feet.

Extending the Lesson:

•Have your students test their knowledge by giving them a bungy cord to tie to an object and then dropping the object from a high point in your school. Let them first compute the k value of the cord, then cut the cord so that the object falls as close to the floor as possible without hitting it.

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featured athlete in the video:

DOUG ANDERSON: Professional high diver; captured First Place in last year's X Games Bungy Jumping competition. A native of Canada, Anderson received a college degree in audio visual engineering communications.

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Energizer Bungy

Activity Sheet

1 *Given a bungy cord with a k of* **150 N/m**, *what is the maximum distance a bungy jumper weighing* **60kg** *will fall using a* **20m** *bungy cord?*

2 *How far will the jumper have fallen before he attains his maximum velocity? (Hint: At what point in his fall will he stop accelerating?)*

3 *What is the maximum velocity the jumper attains? (Hint: The kinetic energy of an object in motion is* $\mathbf{mv^2/2}$.*)*

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Bouncing Bungies

Academic Topics: Force, velocity, acceleration, springs

Academic Courses: Physics

Athletic Activity: Bungy jumping

Background: Quickly plummeting to the earth is only half of bungy jumping. Hopefully, you'll spring back upwards. With the cord pulling at their legs and gravity yanking at their bodies, why don't bungy jumpers get hurt when the cord, fully extended, jerks them upward?

Methodology: First, let's look at the forces acting on the jumper. Right after the jumper leaps, there's only gravity pulling downward on the jumper with the well-known force mg, where m is the mass of the jumper and g is the acceleration due to gravity. As the cord begins to stretch, a second force, the cord, begins pulling the jumper upward. The cord pulls with a force of kx, where x is the distance the cord is stretched from its normal length and k is the spring constant. The spring constant is a measure of the force needed to stretch a spring or other elastic material (like a bungy cord).

The introduction of this new force does not immediately stop the bungy jumper. In fact, it doesn't even slow him down at first. Initially, it just slows the jumper's downward acceleration. As the cord stretches further, it reaches a point where it pulls upward with the same force that gravity pulls downward. Does this stop the jumper? No. It merely stops his downward acceleration. The jumper's velocity is still going downward, so he keeps falling. At this point the jumper feels just as he would in a car that's coasting. He feels no acceleration.

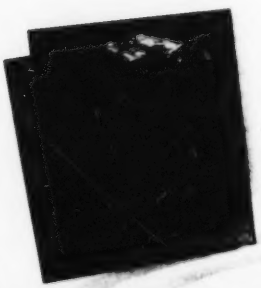
As he falls further, the force from the cord exceeds that of gravity and he starts to accelerate upward. Since he's currently moving down, his "upward acceleration" makes him feels like he's slowly putting the brakes on his descent. As he continues to fall, the upward force from the cord increases and the deceleration brings his fall to a halt. At this point the force from the cord still exceeds that of gravity and the jumper starts accelerating upward in exactly the same way he started accelerating downward when he jumped.

The jumper never feels any sudden change in acceleration throughout his trip, so there's no bone-jarring change in direction that might rip his legs off.

Extending the Lesson:

Drop objects attached by elastic and in-elastic cords from the highest place you can find in your school to illustrate the difference between sudden and gradual changes in acceleration.

• *Challenge your students who know calculus to determine how far a bungy jumper will fall given a mass of 160 lbs and a k value of 112 lbs/s².*



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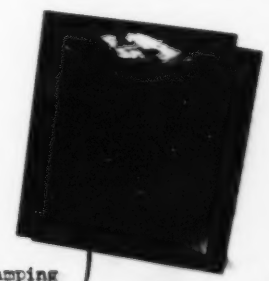
Bouncing Bungies

Activity Sheet

1 *Why can you safely leap off a cliff with a bungy cord but not a normal rope?*

2 *If a bungy jumper weighing* **60kg** *jumps using a* **20m** *rope with a* **k** *value of* **20 N/m**, *how far will she fall before she reaches the maximum velocity of her fall? (Hint: At what point in her fall does she stop accelerating downward?)*

3 *Using the principles described in the segment, explain how a pogo stick works.*



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DOUG ANDERSON: Professional high diver; captured First Place in last year's X Games Bungy Jumping competition. A native of Canada, Anderson received a college degree in audio visual communications.

Learning To Lean

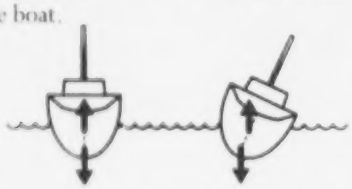
Academic Topics: Force, torque

Academic Courses: Physical science, physics

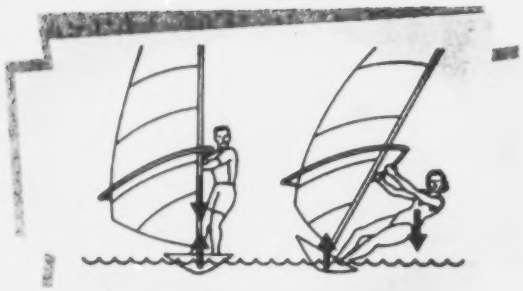
Athletic Activity: Windsurfing

Background: A windsurfer is at an unstable equilibrium when he is standing on his surfboard. If the equilibrium is slightly disturbed, the windsurfer will likely topple over and fall into the water. In this segment we study how leaning helps the windsurfer maintain equilibrium when wind threatens to knock him over.

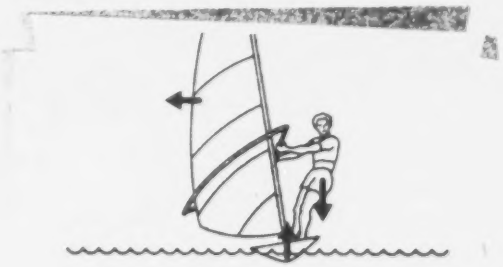
Methodology: Without wind, the forces acting on the windsurfer are the same as those that would act on a large boat. Gravity pulls the boat down and the force of buoyancy exerts an upward force on the boat. The force of gravity acts at the center of mass. The force of buoyancy acts at the center of buoyancy, or the geometrical center of the submerged portion of the boat. As shown in the diagram, the center of gravity for a properly designed boat is below the center of buoyancy. Thus, when the boat lists as shown in the second diagram, the two forces create a torque that acts to right the boat.



The situation is quite different for the windsurfer. The center of gravity is above the center of buoyancy, so when the surfer is tipped a bit there is a destabilizing torque on the board. If no other force acts on the windsurfer, he'll fall into the water.



Wind provides such a force that might destabilize the windsurfer. To prevent the wind from capsizing the surfer, the windsurfer leans against the wind. This leaning moves the center of gravity away from the center of buoyancy. While the wind acts to tilt the board in one direction, the force of gravity provides a torque in the opposite direction. By adjusting how much she leans, the surfer can prevent falling in the water as the wind changes.



Extending the Lesson:

• Examine the concepts of stable and unstable equilibria by using two-by-fours in a tub of water. A two-by-four will naturally settle in the water with one of the two largest faces facing down. In this case, the board is stable much like a boat. If placed in the water with one of the smallest faces facing down, the board is more like the windsurfer—it is unstable.

featured athlete in the video:

JOHN EGAN: A professional skier who has appeared in a number of Warren Miller films, John Egan owns and manages a restaurant and 45-room resort in Vermont. Egan began windsurfing as a child and continues the sport as a hobby.

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Learning To Lean

1 *When an airplane flies, there is an upward force at the wings and a downward force at the tail due to the way the wings and tail are designed. Why must the airplane be loaded so that the center of gravity is in front of the wings?*

2 *Generally a football runner is harder to tackle when he has "a low center of gravity," meaning that his center of gravity is near the ground. Why?*

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The Buoyancy Factor

Academic Topics: Archimedes' Principle

Academic Courses: Physical science, physics

Athletic Activity: Kayaking

Background: In this segment we examine how objects, namely a kayaker and his kayak, are able to float.

Methodology: We know that an object is at equilibrium when all forces on it are balanced. Now consider a kayak floating in the water. Clearly the force of gravity is pulling the boat down, but the boat is not sinking. What force is holding the boat up? The upward force, or buoyant force, is the result of Archimedes' Principle.

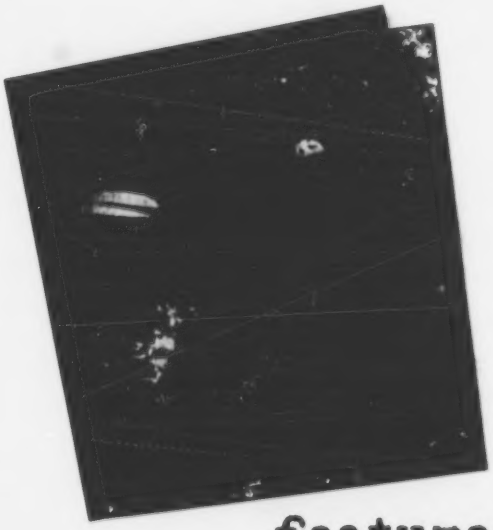
Archimedes' Principle states that an object wholly or partially immersed in a fluid will be buoyed up by a force equal to the weight of the fluid it displaces. For our kayak, this means that the amount of water displaced by the kayak, which is equal to the volume of the kayak which is under water, weighs exactly the same as the kayak and the kayaker. Hence, the buoyant force is equal to the force due to gravity and the kayak doesn't sink.

Extending the Lesson:

Start a discussion of density by asking why the kayak doesn't sink but a stone does. Engage the students to realize that the weight of water displaced by a stone is less than the weight of the stone. Density is how we compare weights of different objects with the same volume. Objects with a density greater than that of water sink and those with a smaller density than water float.

- *Experiment with the concept of buoyancy using other fluids, such as syrup.*

- *Challenge your students to figure out how Archimedes' Principle allows hot air balloons to fly.*



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featured athlete in the video:

ADAM BOYD: Adam Boyd graduated from Woodstock Union High School in Vermont in 1996. He was the fourth top male student in his senior class. Adam will attend Emory College where he will continue his whitewater training with the U.S. men's coaching staff in Atlanta, GA.

espn SPORTS FIGURES

The Buoyancy Factor

Activity Sheet

Consider a board **5cm** *by* **10cm** *by* **100cm** *placed in water:*

1 *Given that the board has a density of* **0.6 g/cm^3**, *how much does the board weigh?*

2 *The density of water is* **1 g/cm^3**. *What volume of water will the board displace? What percentage of the board is under water?*

3 *How could you answer the second part of question (2) without knowing the volume of the board?*

4 *How would you find the density of maple syrup given a bucket of water, a bucket of syrup, and a cube of wood that fits in the buckets?*

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How Sweet It Is

Lesson Plan

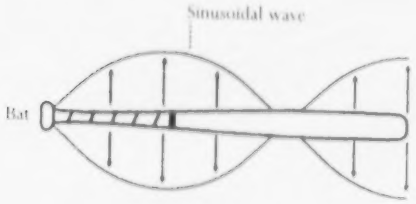
Academic Topics: Standing waves, energy

Academic Courses: Physics or physical science

Athletic Activity: Baseball

Background: Sometimes a batter swings hard and hits the ball, yet the result is a broken-bat dribbler in the infield. How do these hits differ from the booming line drives and towering flies which can result from an equally hard swing?

Methodology: When a bat hits a ball, the bat vibrates. The vibration pattern generally is chaotic, but it can always be broken down into a series of *standing waves*. These are vibrations which form a stable pattern rather than a chaotically changing one. The most important standing wave in a bat oscillates as below.



The more energy that goes into the standing wave, the less energy can go into the hit ball. Hence, the hits that really go far are those that hit the ball in such a way as to not cause the standing wave to vibrate. Those hits that cause the standing wave to vibrate a lot are those which result in weak hits and broken bats, since excess vibration is what causes bats to break.

How can we find the point to hit the ball on the bat which will minimize vibration? The standing wave is such that it vibrates the least at a point about two thirds of the way up the bat (see the diagram), so, if we hit the ball at that point we will get a clean hit. At a point one-third of the way up the standing wave vibrates the most, so a hit there is likely to be weak or even result in a broken bat.

Extending the Lesson:

• Ask students who have played baseball or softball how their hands feel when they hit a dribbler as compared to when they get the ball on the "sweet spot". The response should be that balls hit on the sweet spot don't hurt the hands, while poorly hit balls really sting. Ask the students why this should be (with poorly hit balls, the bat vibrates more, stinging the hands).

• Two simple experiments also show these phenomena nicely. Students can replicate standing waves by shaking one end of a stretchy cord (coiled phone cord works nicely). Also, the sweet spot of a bat can be found by holding the handle end in one hand and dropping a ball against various points on the bat with the other. The point on the bat at which the dropped ball causes the least vibration is the sweet spot. How close is this to two-thirds of the way along the bat, as we can expect from diagram of the standing wave?

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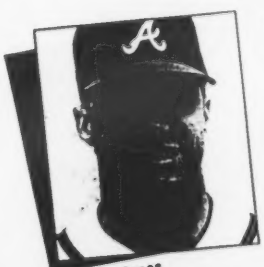

Chipper Jones

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CHIPPER JONES & JASON SCHMIDTS: Atlanta Braves Infielder, Chipper Jones graduated from Bolles High School in Jacksonville, Fl. Jones led Bolles to a state championship with a .448 batting average. Jason Schmidts is a graduate of Kates High School in Washington where he played football, baseball, and basketball. Schmidts was named Gatorade State Player of the Year and All- State.

ESPN SPORTS FIGURES

How Sweet It Is

Activity Sheet

1 *In the discussion, we looked at the first standing wave only. Draw the second and third standing waves in a similar manner.*

2 *Standing waves occur with a* **wavelength** λ, *twice the distance from one node to the next. For example, in our first standing wave the distance from one node (at the hands) to the next (at the sweet spot) is* $\frac{2}{3}L$ *where* L *is the length of the bat. Thus the wavelength of this vibration is* $\lambda = \frac{4}{3}L$. *Find the wavelengths of the next two standing waves that you drew above.*

featured athlete in the video:

CHIPPER JONES & JASON SCHMIDTS: Atlanta Braves Infielder, Chipper Jones graduated from Bolles High School in Jacksonville, Fl. Jones led Bolles to a state championship with a .448 batting average. Jason Schmidts is a graduate of Kates High School in Washington where he played football, baseball, and basketball. Schmidts was named Gatorade State Player of the Year and All- State.

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What A Drag

Lesson Plan

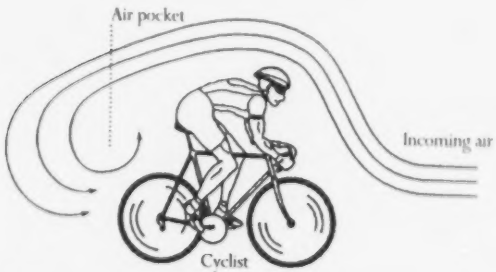
Academic Topics: Aerodynamics, drag

Academic Courses: Physics or physical science

Athletic Activity: Cycling

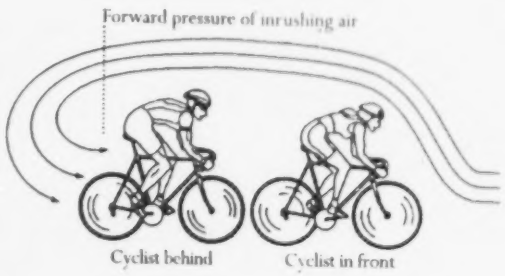
Background: A major part of cycling is learning to *drag* off of other cyclists, using their motion to make one's own movement easier. How does this work?

Methodology: When a cyclist rides, she/he moves through the air. The air is continually pushed out of the way, making it harder to move forward than it would be if there was no air. (This phenomenon is known as *air resistance*. Air, like other fluid and gas substances, has a *viscosity*, which makes it hard to push out of the way.) If a cyclist is moving fast enough, the air that is pushed out of the way cannot rush in behind fast enough and a pocket is formed behind the cyclist where the air density is low.



Another cyclist can make use of this pocket. If one cyclist rides close behind another, the cyclist who is behind can stay inside the air pocket of the one in front, dramatically reducing the air resistance and making it easier to move at the same speed.

But it gets even better. The cyclist in the air pocket isn't just unaffected by air resistance, she/he is actually helped by it! Air rushes in to fill the pocket, exerting a *forward* pressure on the cyclist in the pocket.



Extending the Lesson:

• *Try an experiment as follows. Hang two small weights from strings several inches apart and blow a fan on the two weights so that they swing backwards due to the force of the air. Then place a cylindrical object some distance in front of one of the weights. If the cylinder is close enough, you should be able to see the weight swing somewhat toward the blocking object, due to the air rushing back into the air pocket. Draw diagrams of the airflow to show what is happening.*

• *Ask students to name some innovations in bikes or cars that have appeared in recent years to make them more aerodynamic. What do these innovations have in common? (They tend to form smoother edges so that air can hug the contours of the object, rather than separating and forming an air pocket.)*

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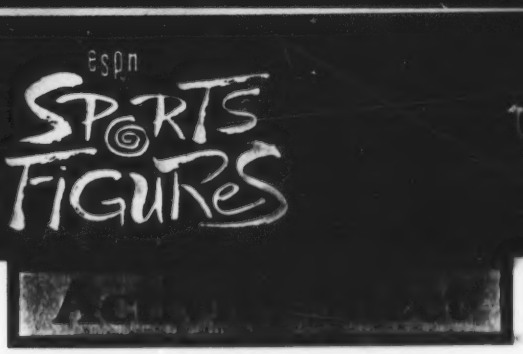
featured athlete in the video:

VERMONT WOMEN'S CYCLING TEAM: The Vermont Women's Cycling Team was founded in 1995 by women hoping to unite many of Vermont's talented road and off-road cyclists. The organization helps women riders get into racing, develop training schedules and assists in establishing sponsorships for them.



What A Drag

1 *When air moves in smooth layers, the motion is called* **laminar**, *whereas chaotic, swirling motion is called* **turbulent**. *Is the air in the air pocket behind a cyclist in laminar or turbulent motion?*

2 *Draw airflow lines over the profile of an old time, boxy car and a modern, aerodynamic car. Which areas in each picture are laminar? Turbulent?*

3 *Explain in common sense terms why sharp edges lead to turbulent air motion and are avoided by today's designers.*

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Sports Figures

Ice Is Cool

Lesson Plan

Academic Topics: Pressure, liquid/solid transitions, molecules, density

Academic Courses: Chemistry or physical science

Athletic Activity: Ice skating

Background: Why is it that we can skate on ice, but not on any other substance, whether concrete, metal, or plastic?

Methodology: Every substance is made out of molecules: tiny particles. When a substance gets hotter, the molecules are moving around faster which makes the material tend to expand. In particular, the solid form of almost everything is denser than the liquid form.

When we say "denser," we mean that given an equal volume of the solid and liquid substances, the solid will weigh more. In general, the *density* of a substance, *rho*, is the mass m divided by the volume, v: $\rho = m/v$.

What makes water unique as a material is that the solid form, ice, is actually less dense than the liquid form, water. Thus when we compress ice, making it more dense, it has no choice but to transform into water.

The water formed by compressing ice is what we're actually skating on when we are "ice skating." We scoot along on a tiny layer of water which immediately refreezes when we are past.

This explains why we cannot skate on other substances; no other common substance has the density properties of ice.

Extending the Lesson:

• Have students think of the physical ramifications of ice being less dense than water. Good answers include the ice in a frozen lake floating on top of the water below rather than sinking to the bottom; the fact that freezing a soda can makes it burst; bursting water pipes; icebergs.

• Repeat the wire-in-the-ice experiment, either in the freezer or outside on a cold day.

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featured athlete in the video:

PAUL WYLIE : Paul Wylie is a graduate of Harvard College and is currently attending Harvard Law School. As the U.S. Olympic Skating Team captain, Wylie startled the skating world by outperforming the best at the 1992 Winter Olympics, resulting in a Silver medal.

espn SPORTS FIGURES

Ice Is Cool

1 *The density of water is* **1 gram** *per cubic centimeter. A soda can contains* **12 fluid ounces** *of liquid, and a* **fluid ounce** *is equivalent to about* **30 cubic centimeters**. *About how much does the fluid in a soda can weigh if its density is about the same as that of water?*

2 *The density of ice is about* **.92 grams** *per cubic centimeter. If* **1 liter (1000 cubic centimeters)** *of water is frozen, what is the volume of the resulting ice?*

3 *Describe a dream material which would make it possible to skate outdoors in the summertime.*

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Batting By The Books

Lesson Plan

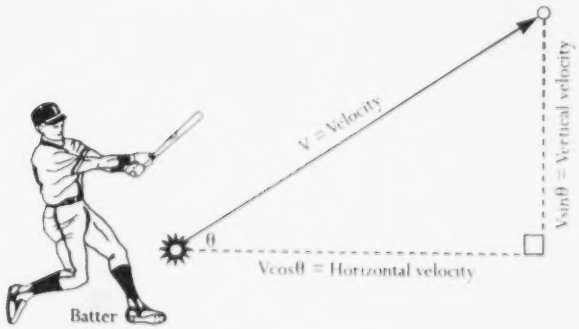
Academic Topics: Velocity, acceleration, trigonometry

Academic Courses: Physics, trigonometry

Athletic Activity: Baseball

Background: Two batters can hit a ball equally hard, but one ball will be an out-of-the-park home run and the other will be a routine fly ball. What else determines how far a ball flies besides how hard it's hit?

Methodology: The missing factor is the angle at which the ball is hit. When the ball leaves the bat at a certain velocity V and angle θ, we can use trigonometry to break the velocity down into a vertical velocity $V \sin \theta$ and a horizontal velocity $V \cos \theta$.



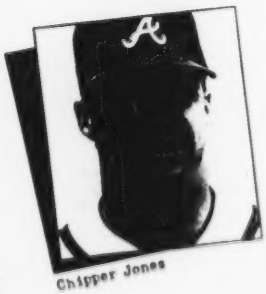
Since the horizontal velocity stays about the same throughout the ball's flight, all we need to do is to figure out how long the ball is in the air. The formula for a ball's height t seconds after it is hit, is $-16t^2 + V_0 t + h_0$, where V_0 is the starting upward speed and h_0 is the starting height. (This equation is standard in first year physics.) In our case, V_0 equals $V \sin\theta$ and we can ignore h_0 since the ball starts out so close to the ground, so our formula is $-16t^2 + Vt \sin \theta$.

We need to find where our equation equals zero, since that means the height is zero and the ball has hit the ground. Solving $-16t^2 + Vt \sin\theta = 0$, we get $t = V \sin \theta / 16$ seconds. Since this is how long the ball is in the air, we multiply by the horizontal velocity, $V \cos \theta$, to see that the ball travels $V^2 \sin \theta \cos \theta / 16$ feet. Finally, we can use trig to simplify this to $V^2 \sin 2\theta / 32$, a neat formula for the distance the ball will travel.

Extending the Lesson:

• We made the assumption that h_0 could be ignored. Realistically, it's about 3 feet. Solve the equation using this value to prove that the difference really is negligible. (You'll need the quadratic formula.)

• Ask students to guess at the angle and speed of a big league home run and plug the values into the formula (converting miles per hour to feet per second for the speed) to see if the distance you get would really be a homer in the local ballpark. (Big league home runs are typically around 350-400 feet.)


Chipper Jones

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featured athlete in the video:

CHIPPER JONES & JASON SCHMIDTS: Atlanta Braves Infielder, Chipper Jones graduated from Bolles High School in Jacksonville, Fl. Jones led Bolles to a state championship with a .448 batting average. Jason Schmidts is a graduate of Kates High School in Washington where he played football, baseball, and basketball. Schmidts was named Gatorade State Player of the Year and All- State.

SPORTS FIGURES

Batting By The Books

1 *If the formula for the distance the ball travels is as above, what angle of hit will travel the farthest?*

2 *If a ball is hit at an angle of* **60 degrees** *and needs to travel* **300 feet**, *what is the minimum speed it can have?*

3 *One factor was neglected in our discussion which means that balls won't go as far as we say they will. What is that factor?*

Chipper Jones

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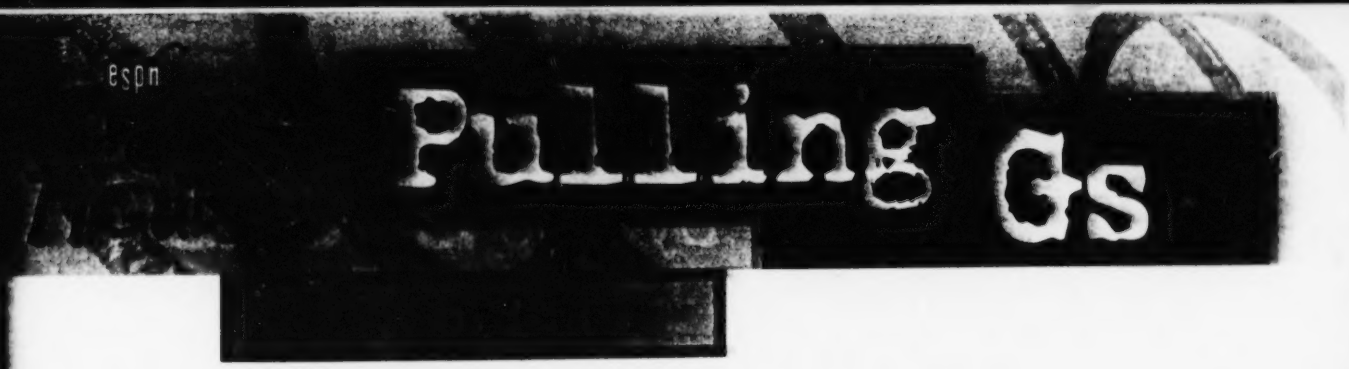

Pulling Gs

Academic Topics: Acceleration, force

Academic Courses: Physics or physical science

Athletic Activity: Aerobatics

Background: What does it mean when a pilot "pulls Gs"?

Methodology: All during our lives, the earth pulls on our bodies with a constant gravitational force. We call this force 1 G. Whenever we accelerate, whether in a car or a rocket, it is as though a force equal to the acceleration is pushing on us and we can quantify these forces by comparing them to the 1 G to which we are subjected all the time.

As an example, consider a plane which accelerates from 100 mph to 200 mph over 10 seconds. Converting from miles per hour to feet per second, the plane accelerates from 147 ft/s to 294 ft/s over 10 seconds, so it accelerates by 147 ft/s in 10 seconds. Thus it accelerates at a rate of 14.7 ft/s per second, or 14.7 ft/s^2. Since the acceleration of gravity is 32 ft/s^2, our 14.7 is 14.7/32=.459 Gs.

In stunt flying, pilots may endure many more Gs than this, up to 5 Gs or even 10 Gs for short times. In going through tight loops, for example, the acceleration a is determined by the equation $a=v^2/r$, where v is the velocity and r is the radius of the loop.

Extending the Lesson:

Test students' intuition by asking them to guess the Gs endured in an ordinary and a high performance car acceleration. Compare the results to the answers of the first two questions on the activity sheet. After solving the third question on the activity sheet, demonstrate how, if the weight is spun in a vertical plane, it actually undergoes one extra G at the bottom of the cycle and one fewer G at the top, since the earth's gravity cancels out one G at the top and adds one at the bottom. Demonstrate by spinning a weight attached to the end of a stretchy cord — the cord will stretch more at the bottom of the cycle than at the top.

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featured athlete in the video:

PATTY WAGSTAFF: Patty Wagstaff is a three-time U.S. National Aerobatics Champion and a six time recipient of the "First Lady of Aerobatics" Betty Skelton Award. Wagstaff has trained with the Russian Aerobatics Team in the Soviet Union. She flies airshows and competitions throughout the world.

ESPN SPORTS FIGURES

Pulling Gs

1 *A family sedan in normal driving accelerates from* **0-60 mph** *in 16 seconds. How many Gs are the occupants subjected to?*

2 *A high performance car driven by an expert goes from* **0-60 mph** *in 4 seconds. How many Gs does the driver endure?*

3 *A weight is spun on a* **12-inch** *string at a rate of two rotations per second. How many Gs does the weight undergo?*

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Skysurfing Metrics

Academic Topics: Units

Academic Courses: Physical science

Athletic Activity: Skysurfing

Background: How do units, and metric units in particular, make things easier?

Methodology: Units are simply a way to measure things with a quantity that is meaningful to everyone. Units exist for many quantities, including energy and temperature, but the three basic units are those of length, mass, and time. In the English system of units, which most Americans use, these basic units are the foot, the pound, and the second. In metric units, used virtually everywhere else in the world, the basic units are the meter, kilogram, and second.

To convert from one set of units to another, we take the quantity in one set of units and multiply it by "conversion fractions" to turn it into the other units. For example, since 1 kilogram equals about 2.2 pounds, the fraction 1 kg/2.2 lbs equals 1 and we can use it to convert pounds to kilograms like this:

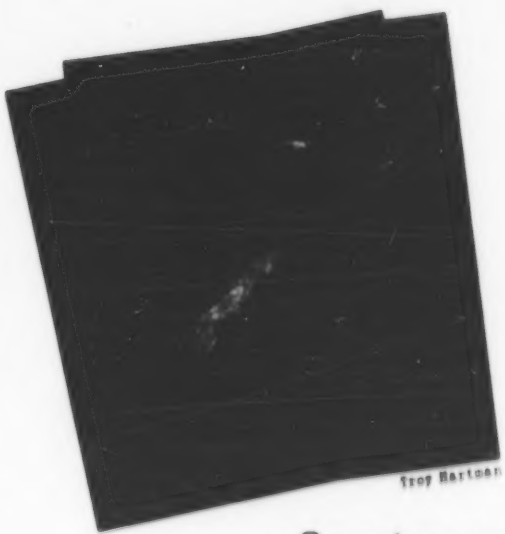
$$3\text{lbs} = \frac{3\text{lbs}}{1} \times \frac{1\text{kg}}{2.2\text{lbs}} = 1.36\ \text{kg}$$

The "lbs" cancels, since it appears once on the top and once on the bottom, leaving 3 pounds equaling 1.36 kilograms. Similar calculations can be used for length, where 1 meter equals about 3.28 feet. For time, both sets of units use the same unit, the second, so no conversion is necessary. However, it is useful to be able to convert from hours to seconds (1 hour equals 3600 seconds).

Extending the Lesson:

• One way to make conversions between sets of units painless is to create shortcuts which aren't quite perfect, but approximate the answer well. For example, instead of trying to remember that one inch is exactly 2.54 centimeters, we can use the approximate figure of two and-a-half centimeters in every inch. Even easier to remember, a foot is about 30 centimeters. Have your students create similar shortcuts for other units and use them to eyeball various measurements in metric.

• Have your class create its own set of length, mass, and time units. For instance, the basic unit of length could be the height of one student, Debbie, and the heights of other students might be .7 Debbies or 1.2 Debbies. Create subunits and conversion factors to both English and metric units.



Troy Hartman

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featured athlete in the video:

TROY HARTMAN & VIC PAPPADATO: Pro skysurfer Troy Hartman has a college degree in aeronautical engineering, in addition to serving three years in the U.S. Air Force. Vic Pappadato is a freefall photographer and also does point-of-view cinematography via his motorcycle, snowboard and skateboard.

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Skysurfing Metrics

1 *Using the rule-of-thumb that a yard is about 10% shorter than a meter, quickly calculate the approximate number of meters in a* **100-yard** *football field.*

2 *Using the exact conversion fraction for feet and meters presented above, plus the fact that a yard is exactly three feet, compute the exact number of meters in a football field.*

3 *If there are* **5,280 feet** *in a mile, come up with an exact conversion fraction and an easy rule-of-thumb conversion between miles and kilometers. (A kilometer is 1000 meters.)*

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Newton's Hat Trick

Academic Topics: Newton's laws

Academic Courses: Physical science, physics

Athletic Activity: Ice hockey

Background: In this segment we use hockey to introduce Newton's three laws of motion.

Methodology: Newton's first law: If a body is at rest, it will remain at rest. If it is moving at a constant velocity, it will continue to do so until a force acts on it. A hockey player is an excellent example of Newton's first law. If he stands still, he won't move. If something, or someone, hits him, or if he pushes against the ice, he'll move. Conversely, if he's gliding on the ice, he'll continue to glide until the friction between his blades and the ice stops him.

Newton's second law: When a force acts on a body, the body is accelerated by an amount which is directly proportional to the force applied and inversely proportional to the mass of the body. In other words, if a player strikes a puck, its acceleration is determined by the mass of the puck and how hard the player hits it. If the puck were larger, it would accelerate less, and if the player hits harder, the puck accelerates more quickly.

Newton's third law: For every force exerted by a body, an equal and opposite force is exerted on the body. When two hockey players collide, they are both hit with an equal force,even if one player is moving and the other is standing still! Even though the target player is standing still, he still exerts just as much force on the hitting player as the player is delivering to him.

Extending the Lesson:

- *Challenge groups of students to develop non-verbal skits illustrating each of Newton's three laws of motion.*
- *Ask your students to identify examples of Newton's laws in other sports.*

featured athlete in the video:

MIKE RICHTER: As goal tender for the N.Y. Rangers, Mike lead his team to a Stanley Cup Championship in 1994. Richter was honored with two prestigious awards last season, including the Thurman Munson Award for his considerable charitable work and the Sloan Kettering Award of Courage for his hospital work. Richter attended the University of Wisconsin.

SPORTS FIGURES

Newton's Hat Trick

1 *How does Newton's third law allow a runner to run?*

2 *As a baseball flies through the air, it seems to slow down. According to Newton's first law, this can't happen unless some force acts on the ball. Where does this force come from?*

3 *According to Newton's second law, a force applied to a heavy object will accelerate it less than it would accelerate a light object. Given this fact, why can you throw a baseball much further than you can throw a wiffle ball?*

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The Racquet Racket

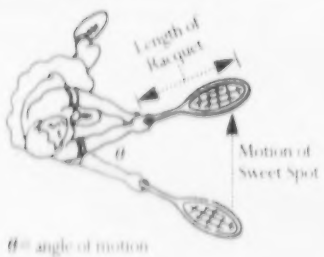
Academic Topics: Angles, similar triangles, speeds

Academic Courses: Physical science, basic math

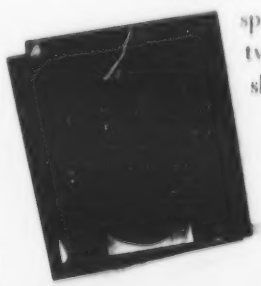
Athletic Activity: Tennis

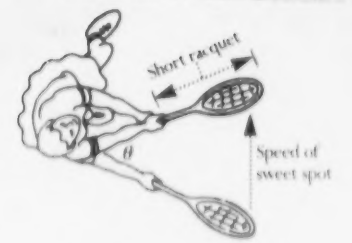
Background: Why do longer racquets help many tennis players? What are the problems with longer racquets?

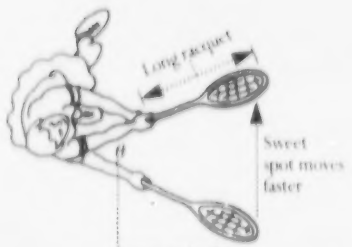
Methodology: When tennis players hit a ball, they move their arm in an angle. The part of the racquet which will contact the ball, the "sweet spot," moves as a result. The faster the sweet spot is moving, the faster the ball will be hit.



When the racquet gets longer, the same arm movement packs more punch, since the sweet spot has to move further. Compare the two similar triangles below, one with a shorter racquet, one with a longer.







Same angle θ, so the two triangles are similar

The two triangles are both isosceles and have the same interior angle, so they are similar by side-angle-side similarity. In similar triangles, every length is proportional to the length of one side; thus the speed of the sweet spot is proportional to the length of the racquet.

Extending the Lesson:

• *Discuss with the class why tennis racquets cannot be arbitrarily long. Why does a player's ability to control where the ball is going begin to suffer as the racquet gets longer?*

• *Ask your class which would be harder to swing, a short racquet or a longer racquet which weighs the same. Explain the concept of* ***moments of inertia*** *to show why the longer racquet is harder to swing.*

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featured athlete in the video:

MALIVAI WASHINGTON: Malivai Washington attended the University of Michigan as a Business Major. In 1996, Washington was named to the United States Olympic Team and was a runner-up finalist at Wimbledon.

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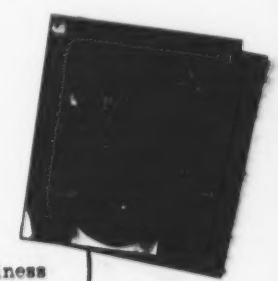
The Racquet Racket

1 *John hits a ball at a speed of* **20 mph** *using his tennis racquet. Denise's racquet is 20% longer and she swings her arm just as fast. How fast does she hit the ball?*

2 *John and Denise use racquets with lengths of* **2 feet** *and* **3 feet,** *and hit the ball at speeds of* **70 mph** *and* **100 mph,** *respectively. They switch racquets and hit again; what is the speed of the balls this time?*

3 *A tennis player swings a racquet through an angle of* **90 degrees** *in one-half of one second. If the sweet spot is three feet from the center of the swing, how fast does the sweet spot travel?*



featured athlete in the video:

MALIVAI WASHINGTON: Malivai Washington attended the University of Michigan as a Business Major. In 1996, Washington was named to the United States Olympic Team and was a runner-up finalist at Wimbledon.

Balanced Forces

Lesson Plan

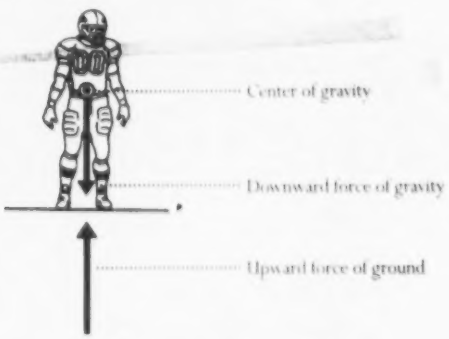
Academic Topics: Force, torque, center of gravity

Academic Courses: Physics, physical science

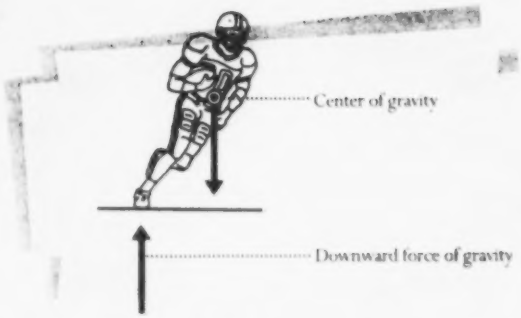
Athletic Activity: Football

Background: How does a low center of gravity help a running back stay upright?

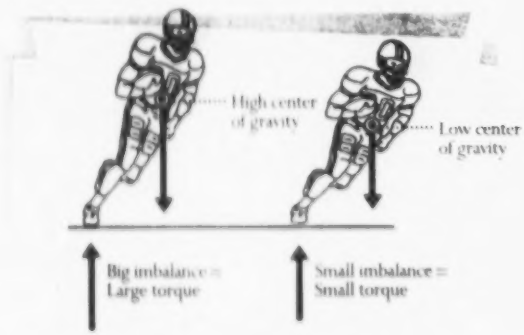
Methodology: Any person stays upright when two forces are in balance: the downward force of gravity and the balancing upward force of the ground. The gravity force pushes down on the person at their "center of gravity" — the point in their body where there is as much weight above as below. The ground's upward force occurs at the person's feet, since that is where the person is pushing into the ground.



When the person is not standing straight up, the two forces are not in perfect balance, since the downward arrow of the gravity force and the upward arrow of the ground's force don't line up.



The two equal but out of balance forces cause a rotational force, or torque, on the person's body, leading them to fall down if the torque gets strong enough. The lower the center of gravity, the farther the person must lean before the forces are out of balance. Even if the weights of two people are the same, the one with the lower center of gravity is harder to tip over.



Extending the Lesson:

- *Ask students to name some situations in which a running back is out of balance and thus needs a low center of gravity. Two answers are: when changing direction rapidly, and when getting hit by a defender.*

- *The amount of torque exerted on a running back by gravity and the ground is equal to the weight of the running back times the horizontal distance between the center of gravity and the ground. Ask students to explain this equality and compute the torque for various objects.*

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Sports Figures

Balanced Forces

1 *Where is the center of gravity of a rectangle?*

2 *Where is the center of gravity of a triangle?*

3 *How much torque is generated by a* **100 kilogram** *running back whose center of gravity is 1 meter misaligned with where his feet are touching the ground?*

Taking Different Tacks

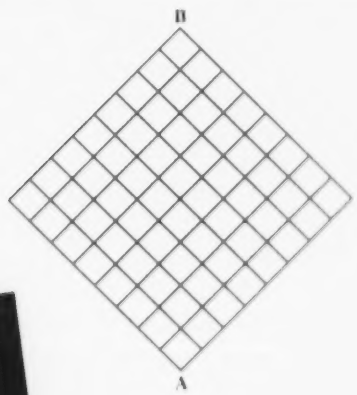
Academic Topics: Distance, basic geometry

Academic Courses: Basic math, geometry

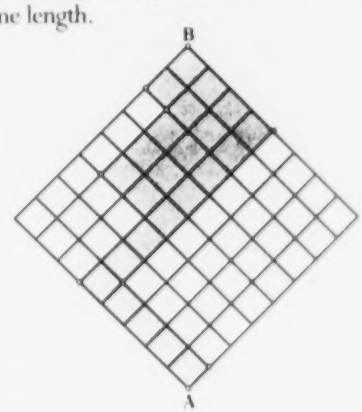
Athletic Activity: Windsurfing

Background: When a windsurfer wishes to sail directly into the wind, he "tacks." This means that instead of going directly into the wind, he goes diagonally to the right, then diagonally to the left, etc., until he reaches his goal. The question this segment addresses is what path the tacking windsurfer should take to minimize the distance he must travel to reach his destination.

Methodology: To figure out which possible path has the shortest length, we split the water into a grid as shown. The windsurfer starts at *A* and wants to go to *B* by traveling along the lines of the grid. We create the grid so that each segment in the grid has the same length; thus, our problem is now getting from *A* to *B* by traveling among the smallest number of short segments.



Clearly, he always wants to go upwards on each move. However, how should he decide whether to go right or left? Looking at the grid, we see that each upward move, whether it be right or left, brings us one upward step closer to the destination. In fact, it doesn't matter whether the surfer goes right or left at each turn on the grid, as long as he goes upwards. In the end, he must take the same number of right paths and left ones no matter which path he takes. Below are a few such successful journeys. Counting the segments covered shows they are the same length.



Extending the Lesson:

- *Challenge the students to prove that in traveling along the grid from **A** to **B** above, the surfer can never move downward if he wishes to minimize the distance he travels.*

- *If your students are unconvinced, have them recreate the experiment by using the grid on a tiled floor, such as a cafeteria.*

- *Challenge your more advanced students to figure out how many shortest possible paths there are to get from **A** to **B** in the grid above. If they figure that out, challenge them to find a general formula for an m by n grid.*

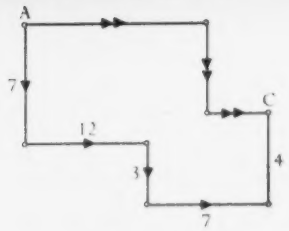
featured athlete in the video:

JOHN EGAN: A professional skier who has appeared in a number of Warren Miller films, John Egan owns and manages a restaurant and 45-room resort in Vermont. Egan began windsurfing as a child and continues the sport as a hobby.

SPORTS FIGURES

Taking Different Tacks

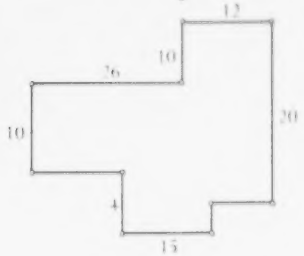
Use the diagram on the right for the first two questions.



1 *What is the length of the path shown by the single arrows?*

2 *How far is it from* **A** *to* **C** *traveling along the double arrows?*

3 *What is the perimeter of the figure shown below?*



featured athlete in the video:

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Answer Key

Steaking Strategies *page 3*

1) No

2) 0, 1, and -1

Not Your Average Average *page 5*

1) Harmonic mean

2) Arithmetic mean

3) 120/7 mph

Energizer Bungy *page 7*

1) 37m

2) 23.9m

3) 20.8m/s

Bouncing Bungies *page 9*

1) A normal rope is not elastic. The force it exerts on the jumper goes from 0 when the rope is not taut immediately to a force equal to that of gravity when the rope is taut. Since the force from the rope does not increase gradually, the deceleration for the jumper is not gradual; it is immediate.

2) 49.4m

3) Exactly like a bungee cord stretches beyond the point it needs to in order to support your weight, the spring of a pogo stick compresses past the point where it would support your weight. When it decompresses to compensate, it shoots you into the air, just like the bungee cord does when it compensates for stretching too far.

Learning to Lean *page 11*

1) If the center of gravity is behind the wings, there are two downward forces acting on the back of the plane and one upward force in the front of the plane. This produces a torque that causes the nose of the plane to tilt upwards drastically (draw it and you'll see).

2) See the SportsFigures segment "Balanced Forces." (The football segment, in case they change the name.)

The Buoyancy Factor *page 13*

1) 3000g

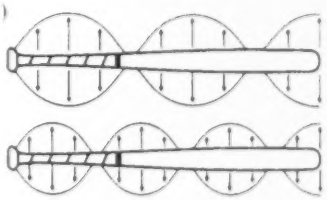
2) $3000cm^3$; 60%

3) Divide the density of the object by the density of water.

4) Measure how much of the wood is submerged in the water, then how much is submerged in the syrup. The density of the syrup is the former volume divided by the latter times the density of water.

How Sweet It Is *page 15*

1)



2) $^4/_5L$ and $^4/_7L$

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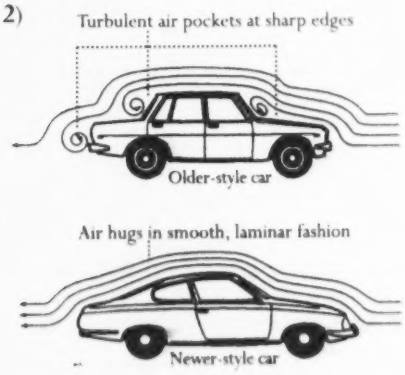
What A Drag *page 17*

1) Turbulent

2)



3) At a sharp edge, air can no longer hug the contour of the object, so it parts from the surface, then rushes in turbulently to fill the void.

Ice Is Cool *page 19*

1) 360 grams

2) 1087 cubic centimeters

3) Liquid denser than the solid, melting point about 120°

Batting By The Book *page 21*

1) 45 degrees

2) About 104 ft/s

3) Air resistance

Pulling Gs *page 23*

1) .17 Gs

2) .69 Gs

3) 2.46 Gs

Skysurfing Metrics *page 25*

1) About 90

2) 91.46

3) 1mi/1.61km, six miles is about ten kilometers

Newton's Hat Trick *page 27*

1) Through friction, a runner exerts a force backwards on the ground. The ground then exerts an equal and opposite force on the runner, sending her forward.

2) The air exerts a drag force on the ball due to friction between the air and the ball.

3) Once a wiffle ball is in flight, friction between the ball and the air decelerates the ball much more quickly than the air can slow a baseball. (Consider the momentum difference, too!)

The Racquet Racket *page 29*

1) 24 mph

2) 105 mph and 66 mph

3) 3π feet/sec

Balanced Forces *page 31*

1) At the Center

2) At the Centroid

3) 100 Newtons

Taking Different Tacks *page 33*

1) 27

2) 23

3) 124

Notes

About The Educational Advisors

Richard Ruszczyk has spent most of his education and professional career inspiring students to excel in mathematics. He has taught publicly and privately, redesigned mathematics and science curriculums, written several textbooks and served as a guest teacher for the Mu Alpha Theta National Convention and the Rose-Hulman Young Scholars Program for advanced math students.

While studying at Princeton, Mr. Ruszczyk helped create The Mandelbrot Competition, a high school contest for the best mathematics students in the United States. After graduating, Mr. Ruszczyk co-wrote "The Art of Problem Solving" for students in grades 7-12 who are involved in extracurricular mathematics.

Richard Ruszczyk graduated summa cum laude from Princeton University in 1993 with a degree in Chemical Engineering. Mr. Ruszczyk continues to stay involved with several nationally acclaimed mathematics competitions and conventions. He is currently employed at D.E. Shaw & Company in New York City.

Sandor Lehoczky is a graduate of Princeton University with a degree in Physics and a minor in Applied Mathematics. While studying at Princeton, Mr. Lehoczky helped create The Mandelbrot Competition, a high school contest for the best mathematics students in the United States. Mr. Lehoczky also co-wrote the two-volume textbook set "The Art of Problem Solving" for students in grades 7-12 who are involved in extracurricular mathematics.

Sandor Lehoczky is currently employed at the Chicago Board Option Exchange where he will complete his studies as an options trader.

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1996-97 SportsFigures Schedule* (cont'd)

DECEMBER '96

Date	Time (ET)	Title/Athete/Sport	Math or Physics Topic
Mon., 12-2	4-4:30 am	'95 SHOW #7 - **Victor's Vectors** featuring Steve Young (Football)	Algebra: Combining Signed Numbers
		The Curveball Controversy featuring Vero Beach Dodger (Baseball)	General Physics: Newton's Third Law
		Banking on Force featuring Lyn St. James (Billiards)	General Physics: Centripetal force, force
Sat., 12-7	7-7:30 am	'95 SHOW #7 - Re-air	
Mon., 12-9	4-4:30 am	'96 SHOW #1 - **Learning to Lean** featuring John Egan (Windsurfing)	Basic Physics: Archimedes Principle
		Sky Surfing Metrics featuring Troy Hartman & Vic Pappadato (Sky Surfing)	General Science: Units
Sat., 12-14	7-7:30 am	'96 SHOW #1 - Re-air	
Mon., 12-16	4-4:30 am	'96 SHOW #2 - **Energized Bungy** featuring Doug Anderson (Bungy Jumping)	Basic Physics: Gravitational potential energy; springs
		Ice is Cool featuring Paul Wylie (Ice Skating)	General Science: Pressure; liquid/solid transitions; molecules; density
Sat., 12-21	7-7:30 am	'96 SHOW #2 - Re-air	
Mon., 12-23	4-4:30 am	'96 SHOW #3 - **The Buoyance Factor** featuring Adam Boyd (Kayaking)	Physical Science, physics: Archimedes Principle
		Not Your Average Average featuring Vermont Women's Cycling Team (Cycling)	Algebra: Averages; rates and distance
Sat., 12-28	7-7:30 am	'96 SHOW #3 - Re-air	
Tue., 12-31	4-4:30 am	'96 SHOW #4 - **What a Drag** featuring Vermont Women's Cycling Team (Cycling)	General Science: Aerodynamics; drag
		Batting by the Books featuring Chipper Jones & Jason Schmidts (Baseball)	Basic Physics: Velocity; acceleration; trigonometry
Sat., 1-4	7-7:30 am	'96 SHOW #4 - Re-air	

JANUARY '97

Sat., 1-11	7:30-8 am	'96 SHOW #4 - **What a Drag** featuring Vermont Women's Cycling Team (Cycling)	General Science: Aerodynamics; drag
		Batting by the Books featuring Chipper Jones & Jason Schmidts (Baseball)	Basic Physics: Velocity; acceleration; trigonometry
Tue., 1-14	3-3:30 am	'96 SHOW #5 - **Newton's Hat Trick** featuring Mike Richter (Ice Hockey)	Basic Physics: Newton's Laws
		Pulling G's featuring Patty Wagstaff (Aerobatics)	Basic Physics: Acceleration; force
Sat., 1-18	7:30-8 am	'96 SHOW #5 - Re-air	
Mon., 1-20	3:30-4 am	'96 SHOW #6 - **The Racquet Racket** featuring Malivai Washington (Tennis)	Basic Physics: Angles; similar triangles; speeds
		How Sweet It Is featuring Chipper Jones & Jason Schmidts (Baseball)	General science: Standing waves; energy
Sat., 1-25	7:30-8 am	'96 SHOW #6 - Re-air	
Mon., 1-27	3:30-4 am	'96 SHOW #7 - **Balanced Forces** featuring Jerome Bettis (Football)	Basic Physics: Force, torque, center of gravity
		Newton's Hat Trick featuring Mike Richter (Ice Hockey)	Basic Physics: Newton's Laws
Sat., 2-1	7:30-8 am	'96 SHOW #7 - Re-air	

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1996-97 SportsFigures Schedule* (cont'd)

FEBRUARY '97

Date	Time (ET)	Title/Athete/Sport	Math or Physics Topic
Mon., 2-3	5:30-6 am	'96 SHOW #8 - **Streaking Statistics** featuring Karl Malone (Basketball) **Bounding Bungies** featuring Doug Anderson (Bungy Jumping) **A Fistful of Tacks** featuring John Egan (Windsurfing)	Algegra: Percents, basic statistic Basic Physics: Force, velocity, acceleration, springs Basic Physics
Sat., 2-8	7:30-8 am	'96 SHOW #8 - Re-air	
Tue., 2-11	5:30-6 am	'95 SHOW #1 - **Why Do Golf Balls Have Dimples** featuring Tiger Woods (Golf) **Geo Basketball** featuring Georgetown Women's Basketball Team (Basketball) **Victor's Vectors** featuring Steve Young (Football)	Basic Physics: Newton's Third Law Geometry: Right Triangles, Trigonometry, Circles Algebra: Combining Signed Numbers
Sat., 2-15	7:30-8 am	'95 SHOW #1 - Re-air	
Tue., 2-18	3-3:30 am	'95 SHOW #2 - **Torquing Tennis Balls** featuring Patrick McEnroe (Tennis) **Stealing With Pythagorean** featuring Vero Beach Dodgers (Baseball) **Bike Force** featuring Peter Webber (Cycling)	Basic Physics: Torque, force Algebra: Pythagorean Theorem, solving equations General Physics: Centripetal force, angular momentum
Sat., 2-22	7:30-8 am	'95 SHOW #2 - Re-air	
Tue., 2-25	3-3:30 am	'95 SHOW #3 - **Baseball x Algebra** featuring Vero Beach Dodgers (Baseball) **Cosines** featuring Jim Kelly (Football) **Shifting Gears** featuring Pete Webber (Cycling)	Algebra: Distance formula Basic Physics: Laws of Cosines, Quadratic Formula Geometry: Ratio, proportion, circumference of a circle
Sat., 3-1	7:30-8 am	'95 SHOW #3 - Re-air	

MARCH '97

Mon., 3-3	4-4:30 am	'95 SHOW #4 - **Better Tennis Through Geometry** featuring John McEnroe (Tennis) **Breaking Even** featuring Reggie Jackson (Baseball)	Geometry: Triangle similarity, evaluating formulas Algebra: Solving Linear Equations
Sat., 3-8	7:30-8 am	'95 SHOW #4 - Re-air	
Mon., 3-10	4-4:30 am	'95 SHOW #5 - **The Bernoulli Principle** featuring Lyn St. James (Auto Racing) **Torquing Tennis Balls** featuring Patrick McEnroe (Tennis) **Reflecting Pools** featuring Loree Jon James (Billiards)	General Physics: The Bernoulli Principle Basic Physics: Torque, force Geometry: Reflection, congruent triangles
Sat., 3-15	7:30-8 am	'95 SHOW #5 - Re-air	
Mon., 3-17	4-4:30 am	'95 SHOW #6 - **The Doppler Effect** featuring Lyn St. James (Auto Racing) **The Spiral Zone** featuring Jim Kelly (Football) **How Physics Saved My Diving** featuring Jill Unikel (Diving)	General Physics: The Doppler Effect General Physics: Angular momentum, drag General Physics: Rotational inertia, angular momentum
Sat., 3-22	6:30-7 am	'95 SHOW #6 - Re-air	
Mon., 3-24	4-4:30 am	'95 SHOW #7 - **Victor's Vectors** featuring Steve Young (Football) **The Curveball Controversy** featuring Vero Beach Dodger (Baseball) **Banking on Force** featuring Lyn St. James (Billiards)	Algebra: Combining Signed Numbers General Physics: Newton's Third Law General Physics: Centripetal force, force
Sat., 3-29	7:30-8 am	'95 SHOW #7 - Re-air	
Mon., 3-31	4-4:30 am	'96 SHOW #1 - **Learning to Lean** featuring John Egan (Windsurfing) **Sky Surfing Metrics** featuring Troy Hartman & Vic Pappadato (Sky Surfing)	Basic Physics: Archimedes Principle General Science: Units

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1996-97 SportsFigures Schedule* (cont'd)

Date	Time (ET)	Title/Athete/Sport		Math or Physics Topic
APRIL '97				
Mon., 4-7	4-4:30 am	'96 SHOW #2	**Energized Bungy** featuring Doug Anderson (Bungy Jumping) **Ice is Cool** featuring Paul Wylie (Ice Skating)	Basic Physics: Gravitational potential energy; springs General Science: Pressure; liquid/solid transitions; molecules; density
Sat., 4-12	7:30-8 am	'96 SHOW #2	Re-air	
Mon., 4-14	3-3:30 am	'96 SHOW #3	**The Buoyance Factor** featuring Adam Boyd (Kayaking) **Not Your Average Average** featuring Vermont Women's Cycling Team (Cycling)	Physical Science, physics: Archimedes Principle Algebra: Averages; rates and distance
Sat., 4-19	7:30-8 am	'96 SHOW #3	Re-air	
Mon, 4-21	5:30-6 am	'96 SHOW #4	**What a Drag** featuring Vermont Women's Cycling Team (Cycling) **Batting by the Books** featuring Chipper Jones & Jason Schmidts (Baseball)	General Science: Aerodynamics; drag Basic Physics: Velocity; acceleration; trigonometry
Sat., 4-26	7:30-8 am	'96 SHOW #4	Re-air	
Sat., 5-3	6:30-7 am	'96 SHOW #5	**Newton's Hat Trick** featuring Mike Richter (Ice Hockey) **Pulling G's** featuring Patty Wagstaff (Aerobatics)	Basic Physics: Newton's Laws Basic Physics: Acceleration; force
MAY '97				
Tue., 5-6	5:30-6 am	'96 SHOW #6	**The Racquet Racket** featuring Malivai Washington (Tennis) **How Sweet It Is** featuring Chipper Jones & Jason Schmidts (Baseball)	Basic Physics: Angles; similar triangles; speeds General science: Standing waves; energy
Sat., 5-10	7:30-8 am	'96 SHOW #6	Re-air	
Tue., 5-13	3-3:30 am	'96 SHOW #7	**Balanced Forces** featuring Jerome Bettis (Football) **Newton's Hat Trick** featuring Mike Richter (Ice Hockey)	Basic Physics: Force, torque, center of gravity Basic Physics: Newton's Laws
Sat., 5-17	7:30-8 am	'96 SHOW #7	Re-air	
Mon., 5-19	4-4:30 am	'96 SHOW #8	**Streaking Statistics** featuring Karl Malone (Basketball) **Bounding Bungies** featuring Doug Anderson (Bungy Jumping) **A Fistful of Tacks** featuring John Egan (Windsurfing)	Algegra: Percents, basic statistic Basic Physics: Force, velocity, acceleration, springs Basic Physics
Sat., 5-24	7:30-8 am	'96 SHOW #8	Re-air	
Mon., 5-26	4-4:30 am	'95 SHOW #1	**Why Do Golf Balls Have Dimples** featuring Tiger Woods (Golf) **Geo Basketball** featuring Georgetown Women's Basketball Team (Basketball) **Victor's Vectors** featuring Steve Young (Football)	Basic Physics: Newton's Third Law Geometry: Right Triangles, Trigonometry, Circles Algebra: Combining Signed Numbers
Sat., 5-31	7:30-8 am	'95 SHOW #1	Re-air	
JUNE '97				
Mon., 6-2	4-4:30 am	'95 SHOW #2	**Torquing Tennis Balls** featuring Patrick McEnroe (Tennis) **Stealing With Pythagorean** featuring Vero Beach Dodgers (Baseball) **Bike Force** featuring Peter Webber (Cycling)	Basic Physics: Torque, force Algebra: Pythagorean Theorem, solving equations General Physics: Centripetal force, angular momentum
Sat., 6-7	7:30-8 am	'95 SHOW #2	Re-air	
Mon., 6-9	4-4:30 am	'95 SHOW #3	**Baseball x Algebra** featuring Vero Beach Dodgers (Baseball) **Cosines** featuring Jim Kelly (Football) **Shifting Gears** featuring Pete Webber (Cycling)	Algebra: Distance formula Basic Physics: Laws of Cosines, Quadratic Formula Geometry: Ratio, proportion, circumference of a circle
Sat., 6-14	7:30-8 am	'95 SHOW #3	Re-air	
Mon., 6-16	5:30-6 am	'95 SHOW #4	**Better Tennis Through Geometry** featuring John McEnroe (Tennis) **Breaking Even** featuring Reggie Jackson (Baseball)	Geometry: Triangle similarity, evaluating formulas Algebra: Solving Linear Equations
Sat., 6-21	7-7:30 am	'95 SHOW 4	Re-air	
Tue., 6-24	5-5:30 am	'95 SHOW #5	**The Bernoulli Principle** featuring Lyn St. James (Auto Racing) **Torquing Tennis Balls** featuring Patrick McEnroe (Tennis) **Reflecting Pools** featuring Loree Jon James (Billiards)	General Physics: The Bernoulli Principle Basic Physics: Torque, force Geometry: Reflection, congruent triangles
Sat., 6-28	7:30-8 am	'95 SHOW #5	Re-air	

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1996-97 SportsFigures Schedule*

OCTOBER '96

Date	Time (ET)	Title/Athete/Sport	Math or Physics Topic
Tue., 10-1	4-4:30 am	'96 SHOW #5 - **Newton's Hat Trick** featuring Mike Richter (Ice Hockey)	Basic Physics: Newton's Laws
		Pulling G's featuring Patty Wagstaff (Aerobatics)	Basic Physics: Acceleration, force
Sat., 10-5	7:30-8 am	'96 SHOW #5 - Re-air	
Tue., 10-8	3:30-4 am	'96 SHOW #6 - **The Racquet Racket** featuring Malivai Washington (Tennis)	Basic Physics: Angles, similar triangles, speeds
		How Sweet It Is featuring Chipper Jones & Jason Schmidts (Baseball)	General science: Standing waves, energy
Sat., 10-12	7:30-8 am	'96 SHOW #6 - Re-air	
Tue., 10-15	4-4:30 am	'96 SHOW #7 - **Balanced Forces** featuring Jerome Bettis (Football)	Basic Physics: Force, torque, center of gravity
		Newton's Hat Trick featuring Mike Richter (Ice Hockey)	Basic Physics: Newton's Laws
Sat., 10-19	7:30-8 am	'96 SHOW #7 - Re-air	
Tue., 10-22	4-4:30 am	'95 SHOW #1 - **Why Do Golf Balls Have Dimples** featuring Tiger Woods (Golf)	Basic Physics: Newton's Third Law
		Geo Basketball featuring Georgetown Women's Basketball Team (Basketball)	Geometry: Right Triangles, Trigonometry, Circles
		Victor's Vectors featuring Steve Young (Football)	Algebra: Combining Signed Numbers
Tue., 10-29	4-4:30 am	'95 SHOW #2 - **Torquing Tennis Balls** featuring Patrick McEnroe (Tennis)	Basic Physics: Torque, force
		Stealing With Pythagorean featuring Vero Beach Dodgers (Baseball)	Algebra: Pythagorean Theorem, solving equations
		Bike Force featuring Peter Webber (Cycling)	General Physics: Centripetal force, angular momentum
Sat., 11-2	7:30-8 am	'95 SHOW #2 - Re-air	

NOVEMBER '96

Tue., 11-5	3:30-4 am	'95 SHOW #3 - **Baseball x Algebra** featuring Vero Beach Dodgers (Baseball)	Algebra: Distance formula
		Cosines featuring Jim Kelly (Football)	Basic Physics: Laws of Cosines, Quadratic Formula
		Shifting Gears featuring Pete Webber (Cycling)	Geometry: Ratio, proportion, circumference of a circle
Sat., 11-9	6:30-7 am	'95 SHOW #3 - Re-air	
Tue., 11-12	3:30-4 am	'95 SHOW #4 - **Better Tennis Through Geometry** featuring John McEnroe (Tennis)	Geometry: Triangle similarity, evaluating formulas
		Breaking Even featuring Reggie Jackson (Baseball)	Algebra: Solving Linear Equations
Sat., 11-16	6:30-7 am	'95 SHOW #4 - Re-air	
Tue., 11-19	4-4:30 am	'95 SHOW #5 - **The Bernoulli Principle** featuring Lyn St. James (Auto Racing)	General Physics: The Bernoulli Principle
		Torquing Tennis Balls featuring Patrick McEnroe (Tennis)	Basic Physics: Torque, force
		Reflecting Pools featuring Loree Jon James (Billiards)	Geometry: Reflection, congruent triangles
Sat., 11-23	6:30-7 am	'95 SHOW #5 - Re-air	
Tue., 11-26	4-4:30 am	'95 SHOW #6 - **The Doppler Effect** featuring Lyn St. James (Auto Racing)	General Physics: The Doppler Effect
		The Spiral Zone featuring Jim Kelly (Football)	General Physics: Angular momentum, drag
		How Physics Saved My Diving featuring Jill Unikel (Diving)	General Physics: Rotational inertia, angular momentum
Sat., 11-30	6:30-7 am	'95 SHOW #6 - Re-air	

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